



— CITY OF PORTLAND —
ENVIRONMENTAL SERVICES



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**Reconnaissance PFAS Sampling Plan
Fire Station 2 Training Facility
Portland, Oregon**

City of Portland
Bureau of Environmental Services
Coordinated Site Analysis Program

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1.0 Introduction

The City of Portland's Bureau of Environmental Services (BES), Coordinated Site Analysis (CSA) Program, was requested by the Portland Fire Bureau to conduct environmental sampling at the training facility at 4800 NE Sandy Blvd to assess if Per- and Polyfluoroalkyl Substances (PFAS), associated with the use of AFFF (aqueous film forming foam) type firefighting foam at the training ground, have impacted the site (Figure 1). PFAS are a complex family of compounds that are considered emerging contaminants of concern that present known or potentially unacceptable human health effects or environmental risks and either: (1) do not have regulatory cleanup standards, or (2) regulatory standards are evolving due to new science, detection capabilities or pathways, or both (USDOD, 2009). The complete list of the compounds to be analyzed are provided in Table 1 in Appendix B.

1.1 Purpose and Objectives

This plan documents the methods that will be used to complete the proposed sampling activities. The goal of the reconnaissance sampling is to assess if PFAS have impacted site conditions. To accomplish the objectives, the scope of work described in the plan provides procedures for the following tasks:

1. Installation of four groundwater monitoring wells. One upgradient of the site, two downgradient on the site, and one adjacent to the training zone
2. Collection of three groundwater samples from the four monitoring wells and analysis for PFAS compounds over three-month intervals to capture three seasonal changes.
3. Record groundwater elevation data to support gradient mapping and evaluation of the potential for groundwater migration within the site vicinity.
4. Collection of six soil samples from three sites within the downgradient stormwater swale on the site, two soil samples from the well installation adjacent to the training zone for analysis for PFAS compounds, and one composite sediment sample from catch basins in the training zone.

These activities are discussed in further detail within this plan.

2.0 Background

2.1 Site Description

The Portland Fire & Rescue Training Center (Fire Station 2) at 4800 NE 122nd Ave. is located approximately 0.5 miles south from the Columbia River at an approximate elevation of 33 feet (Figure 1). The property is approximately 8.1 acres and is bordered to the south by a Union Pacific railroad line; to the north by commercial warehouses, to the west by a storage facility, and to the east by a commercial/light industrial complex. Based on verbal conversations with Fire Bureau staff training is conducted on an impervious surface with surface runoff directed northward and intercepted by catch basins. This is delivered to a stormwater swale on the northern boundary of the property. The swale is connected to an outfall pipe that is connected to both storm and sanitary lines in NE 122nd Ave. During trainings, flow is diverted toward the sanitary line via an on-site switch (Figure 2).

2.2 Subsurface Conditions

The near surface geology in the site vicinity is characterized by a thin 5-foot-thick layer of soil and/or Overbank deposits (OD) of fine-grained silt overlying alluvial deposits, consisting of unconsolidated sands, and gravels, overlying poorly to moderately consolidated Troutdale Formation conglomerates. Five hydrogeologic units have been identified within the site vicinity lying stratigraphically from youngest to oldest: Unconsolidated Gravels/Troutdale Gravel Aquifer (UG/TGA), Confining Unit 1 (CU1), Troutdale Sandstone Aquifer (TSA), Confining Unit 2 (CU2) and Sand and Gravel Aquifer (SAG). The unconsolidated alluvial deposits of boulders and cemented gravels of the UG/TGA is the uppermost aquifer. It is generally unconfined and is estimated to extend to a depth of 200 feet below ground surface (bgs). The 150-foot-thick fine silts and clays of the CU1 separates the UG/TGA from the 75-foot-thick poorly consolidated sands and gravels of the TSA. The lowermost aquifer of sands and gravels at a minimum of 500 feet bgs is overlain by clays of the 50-foot-thick, leaky aquitard CU2. A summary of the hydrogeologic units are provided in Table 2.

The United States Geological Survey (USGS) Estimated Depth to Seasonal High Groundwater layer in the ArcGIS mapping program approximates groundwater levels within the entire project area to range from 10 ft. to 20 ft. bgs (Figure 3). The Oregon Water Resources Department (OWRD) maintains records of well logs installed in the state of Oregon. Well logs provide information on groundwater levels, subsurface geologic conditions, and well construction throughout the state. As of December 29, 2017, seven well logs were listed at this location with static water levels ranging from 10.6 ft. to 22 ft. bgs. However, six of the wells were abandoned in September 2006 and the remaining is screened in a deep, confined aquifer. The Portland Water Bureau System layer in the ArcGIS mapping program lists two additional active wells, PR-Piezo-2 & PR-Piezo-4, for which groundwater level monitoring between 2001 and 2014 suggests that the depth to water level in the shallow UG/TGA aquifer ranges from 21 ft. to 24.5 ft. bgs. Active wells are summarized in Table 3. The Portland Water Bureau Columbia South Shore Well Field Model (CSSWF) incorporating both pumping and non-pumping scenarios in the UG/TGA aquifer suggests a northerly groundwater flow path at the base of the OD and UGA and a northwest path at the base of the TGA.

2.3 Background on PFAS

PFAS are a class of approximately 3000 manmade chemicals that were developed in the 1930s. Due to their long fully fluorinated carbon-chain and basic structure they are essentially non-degradable under environmental conditions. They adsorb strongly onto suspended solid particulates and sediments, especially the longer-F-chain (C_{12} - C_{15}), with bioaccumulation increasing steeply with F-chain length. Concerns about the risks that PFAS pose to human health and to the environment were initially focused on the longer-chain chemicals: Perfluorooctane Sulfonate (PFOS) and its derivative Perfluorooctanoic Acid (PFOA). However, as awareness and emphasis on PFAS occurrence in the environment has evolved six substances were included from the third round of monitoring in the USEPA Unregulated Contaminant Monitoring Rule (UCMR3). Many state agencies have expanded on that list by focusing on a balance between both short and long chain substances. Increasingly this attention has been expanded to include the fluorinated alternatives based on the 6:2 and 8:2 fluorotelomer replacements as studies have indicated that these alternatives may ultimately degrade and transform into short-chain PFAS (Wang, 2013).

Beginning in the 1960s PFAS were becoming incorporated into AFFF-type fire suppression foam for use on Class B petroleum based fires. Historically these foams contained long-chain PFAS but with increased awareness of the risk to human health and environment current manufacturing moved toward alternatives such as fluorotelomer-based fluorosurfactants or fluorosurfactant and fluoropolymer free products.

Currently the Portland Fire Bureau does not use Class B fire suppression foam containing long-chain PFAS. However, the nature and historical use of AFFF type foam containing PFAS is not known.

Three types of fire suppression foam concentrate were observed at Fire Station 2 during a site visit in November 2017:

- Silvex Class A fire control concentrate. Part #434467
- Solberg 1% Rehealing TFI training foam concentrate
- Thunderstorm 1% or 3% AR-AFFF

Silvex is designed to address Class A fires and therefore fluorosurfactants are not present. Solberg and Thunderstorm are designed to extinguish Class B fires. Solberg is fluorosurfactant and fluoropolymer free. The fluorosurfactants in Thunderstorm are short chain ($C-6$) fluorotelomer based alternatives. Material Safety Data Sheets of these solutions are included in Appendix B.

2.3.1 Regulation

With recognition of the risks that PFAS substances pose, 3M (the sole producer in the United States) voluntarily phased out 75 chemicals containing PFAS in 2000. By 2006 the EPA had initiated the PFOA Stewardship Program with the goal to achieve 95% reduction by 2010 and complete elimination by 2015.

2.4 Site History and Operations

The property was transferred from the Parkrose Water District to the Portland Fire Training in the early 1990's. Land use prior to acquisition, based on aerial photography, include agricultural use from 1948 to 1966 and limited developed and paving associated with the Parkrose Water District to 1983. Post-acquisition improvements to the site occurred in 1994 with construction of the stormwater swale on the north property line, paving the entire property, installation of the on-site stormwater drainage system, and construction of improved facilities.

Historically AFFF type foam training at the site was conducted monthly but has been suspended since October 2017. Training occurred in the paved area as outlined in Figure 2, however the pavement is in poor condition and highly cracked. Typically, training focused on application methodology with only the rare use of flammable liquid burn pan scenarios incorporating live fire. Despite a lack of intentional hydrocarbons release associated with this training other operations such as extrication trainings and leaking fluids from wrecked vehicles on the south concrete pad have the potential to contribute to non-related PFAS releases of petroleum products, metals, and solvents.

Foam disbursement post training is directed primarily to the stormwater swale via 4 catch basins in the training zone. However, it has been observed that volumes were periodically sufficient to overtop the shallow basins they reside in and migrate directly to the swale and unpaved land east of the training zone. The unlined two-foot-deep swale is 14 feet wide and over 700 feet long on the northern property line. It is covered in natural vegetation and grasses and sloping westward. Stormwater flow drains into a concrete field inlet that during trainings is diverted from the Columbia Slough to the sewer system via a diverter valve. The catch basins are serviced yearly for the removal of debris and sediment.

3.0 Groundwater Investigation

The purpose of the groundwater investigation is to determine if there is a presence of PFAS substances in the site groundwater. Four monitoring wells will be installed and sampled over three changes of seasons. Two wells will be installed on-site downgradient of the fire training operations, one adjacent to the training zone, and one off-site upgradient of the Fire Station facility to determine background groundwater quality (Figure 2). Data collected during the groundwater investigation also will be used to evaluate the potential for groundwater contaminants to migrate to the Columbia slough and groundwater via potential preferential migration pathways (e.g. groundwater infiltration into nearby subsurface conveyance systems.)

3.1 Objectives

The specific objectives of the groundwater investigation include the following:

- Characterize the water-bearing zone beneath the Site;
- Assess whether PFAS are present in shallow groundwater;
- Determine baseline upgradient water quality.

3.2 Monitoring Wells

Four monitoring wells will be installed at the approximate locations shown on Figure 2. Each well will be drilled and installed in accordance with Oregon Administrative Rules (OAR) Chapter 690, Division 240, Construction and Maintenance of Monitoring Wells and Other Holes in Oregon, and DEQ *Ground Water Monitoring Well, Drilling, Construction and Decommissioning Guidelines* (1992). Each well will have a unique identifier, starting with “MW” for monitoring well, followed by a sequential number. Two wells are proposed to be installed downgradient of the training exercises on the north bank of the stormwater swale at MW-1 and MW-2. A third monitoring well is proposed to be installed adjacent to the training zone at MW-3 and an upgradient one of the training exercise in a right-of-way greenspace at MW-4.

A track-mounted hollow stem auger drilling rig will be used to advance soil borings for monitoring well installation. The borehole diameter should be at least 2-inches in diameter. Well drilling and construction activities will be performed by an Oregon-licensed driller. Drilling and well installation activities will be documented by a field hydrogeologist or environmental engineer working under the supervision of an Oregon Registered Geologist (RG) or Professional Engineer (PE). The RG or PE will oversee soil sampling, borehole logging, and well construction activities.

3.2.1 Monitoring Well Design and Construction

The proposed wells are intended to monitor the top of the UG/TGA hydrogeologic unit. Each well is intended to have a 15-foot screen section with approximately 10 feet submerged and 5 feet of screen above the top of the regional static water table. This type of design will ensure that water quality samples collected from these wells are representative of the top of the regional water-bearing zone.

A two-inch diameter groundwater monitoring well will be installed in each boring as the augers are extracted. The monitoring wells will be constructed of 2-inch-diameter Schedule 40, flush-threaded PVC pipe with 15 feet of 0.010-inch milled slot screen. The top of the screen will be placed approximately 5 feet above the groundwater surface to account for seasonal variation. A blank riser pipe attached to the top of the screen will extend to approximately ground surface. Well screen, casing, and caps will be precleaned by the manufacturer and shipped in plastic. A 10-20 graded silica sand pack will be installed within the annular space from the bottom of the screen to 2 feet above the top of the screen. During well construction, the sand pack will be poured slowly through the hollow stem augers as they are extracted to minimize any possibility of bridging. The well screen will be gently surged with a bailer during installation of the sand pack to reduce the potential for bridging and ensure a uniform distribution of the sand around the screen. The annular space above the sand pack will be sealed with bentonite chips to 2 feet below ground surface (bgs), followed by a concrete seal, which will extend to the ground surface. The monitoring wells will be completed with a flush mount monument set in concrete.

3.2.2 Well Development

The objective of the well development is to remove fine-grained material from the filter pack and borehole wall thereby improving the hydraulic connection between the well and the aquifer. Monitoring wells will be developed using a combination of surging, bailing, or other methods approved by the field hydrogeologist. A typical well development sequence is as follows:

- 1) Measure and record depth to water.
- 2) Collect a bailer of groundwater and measure pH, conductivity, and temperature.
- 3) Surge well to loosen sediment within sand pack. Surging is performed with a stainless-steel bailer or surge block that has a slightly smaller diameter than the PVC well casing.
- 4) Bail and/or pump the well to remove sediment and groundwater. Measure pH, conductivity, and temperature and turbidity at regular intervals depending on the yield of the well (e.g., every 2 gallons, 15 minutes).
- 5) Terminate well development after the pH, conductivity, and temperature values stabilize within the goal of 10 percent and turbidity is low (5 – 10 NTU) or the field hydrogeologist terminates the effort.
- 6) Measure and record depth to water after development is complete.
- 7) Well development equipment will be decontaminated between wells.

The new monitoring wells will be developed a minimum of 24-hours after the seal is installed. Well development water will be stored in DOT-approved 55-gallon drums, labeled as non-hazardous waste, and stored on-site in a secure location pending receipt of the groundwater monitoring results and appropriate disposal.

3.2.3 Survey

The locations and elevations each monitoring well will be surveyed by an Oregon licensed surveyor using an established datum. The elevation of the top of each well monument and the ground surface next to each well monument will be surveyed to the nearest 0.1 foot. The survey point at the top of each well casing will be marked by sawing a small, permanent

indentation on the north side of the PVC casing.

3.3 Groundwater Monitoring

The collection of groundwater samples from site monitoring wells generally will consist of three steps:

- 1) Measurement of static water level
- 2) Well purging and monitoring for field parameter stabilization following low flow standards.
- 3) Water quality sample collection

3.3.1 Water Level Measurements

Groundwater levels will be manually measured immediately prior to groundwater sampling. The wells will be uncapped and allowed to equilibrate with atmospheric pressure prior to measurement of groundwater levels. The water level in each well will then be measured from the surveyed top of casing location using an electric sounder to the nearest 0.01 foot. Water level measurements and surveyed measuring point elevations will be used to compute groundwater elevations at each monitoring point. A complete set of static water level measurements will be obtained before initiating a water quality sampling event. In addition, groundwater levels will be measured on a monthly basis between the time the wells are first sampled and receipt of the second round of analytical testing results (estimated 4 – 5 months). Groundwater levels will be used to evaluate the groundwater flow directions and gradients across the Site.

3.3.2 Well Purging, Field Parameter Measurement, and Water Quality Sample Collection

In general, groundwater sampling will proceed in order from background wells (e.g., upgradient) to down gradient wells (i.e., detected groundwater concentrations of contaminants of interest), based on anticipated conditions and previous data collected at the site to reduce the potential for cross-contamination of water samples. Field personnel will determine the appropriate sampling order before conducting sampling in cooperation with the project manager, and BES staff.

Monitoring wells will be purged using appropriate precleaned equipment selected by the field hydrogeologist or engineer (e.g., bladder pump, low flow electric pump). Purge water will be directed through a flow through cell containing field water quality parameter sensors. Groundwater purging and parameter measurement techniques to be used for this project is described below:

- 1) Measure water depth to the nearest 0.01 foot using an electronic water-level sounder. Record depth to water measurement and the time of measurement on the groundwater sampling form.
- 2) Calibrate field meters daily according to factory instructions, with calibration results recorded on calibration forms.
- 3) Lower the pump tubing into the well and connect to the pump and the flow through cell.

- 4) Begin purging, typically at a rate of approximately 500 milliliters per minute, but no more than 1.0 liter per minute. Record the purge rate and time throughout the purging effort.
- 5) Field parameters will be measured using a flow-through device to minimize potential effects from atmospheric exposure. Monitor pH, temperature, conductivity oxidation-reduction potential (Eh), dissolved oxygen (DO), and turbidity (from flow through cell discharge) and record readings at regular intervals (e.g., approximately 2-liter purge interval or 5 minutes). Record parameter measurements on the groundwater sampling form.
- 6) Water levels will be recorded with each parameter set.
- 7) Purging will be considered complete after field parameter measurements agree to within the stability criteria provided in Table 4 in Appendix B.
- 8) Record the final field measured parameters of pH, temperature, conductivity, turbidity, DO, and Eh.
- 9) Purge water will be stored in DOT-approved 55-gallon drums, labeled as nonhazardous waste, and stored on-site in a secure location pending receipt of the groundwater monitoring results and appropriate disposal.

Following well purging, groundwater quality samples will be obtained. Sample bottles will be filled directly from an appropriate sampling port (e.g., bailer, sampling port before the pumped water passes through the flow-through cell, low flow pump discharge). Sampling procedures will be performed in a manner that minimizes disturbance/agitation of the water column or sample (volatilization), and appropriate tubing material will be used to reduce the potential for PFAS contamination [high density polyethylene (HDPE) is acceptable]. Low flow rates will be used during sampling collection.

To avoid PFAS contamination of the groundwater sample, sampling personnel should avoid using items containing polytetrafluoroethylene (PTFE, also known as Teflon) during the sampling process, as well as other items that contain PFAS, such as aluminum foil, post-it notes, Rite in the Rain notebooks, and certain product packaging (e.g. such as that found on pre-wrapped foods and snacks). Similarly, many clothing items contain PFAS, such as those coated with Teflon or incorporating a Gore-Tex membrane. Clothing items should only be worn if they have been washed at least 6 times and known PFAS-containing products should be avoided during sample collection. Before any samples are to be collected, the sample handler must wash their hands and wear nitrile gloves while collecting and sealing sample containers.

Water samples will be placed in appropriate, analytical laboratory-supplied precleaned and preserved containers.

Groundwater sampling equipment reused between monitoring locations (e.g., pump system, low flow cell) will be thoroughly decontaminated between uses, as described in Section 3.6. If tubing is used during groundwater sampling, it will be discarded after each use or dedicated to a single monitoring well.

The effectiveness of the decontamination procedure will be evaluated through the periodic collection of equipment rinsate blanks as outlined in the data quality section.

3.3.3 Sampling Frequency

Three rounds of groundwater sampling and analyses are planned. The first round of samples will be collected at an appropriate time following well development activities (48 hours - 1 week). The second round of samples will be collected approximately 3 months (i.e., one quarter) after the initial sample and the third quarter. After completion of three quarterly sampling events, BES will determine if additional groundwater monitoring is necessary.

3.4 Sample Handling and Documentation

All samples transferred to the laboratory for analysis will follow standard documentation, packing, and chain-of-custody procedures. Samples will be stored in iced coolers or refrigerated following collection, then hand-delivered to the laboratory in iced coolers to maintain sample temperatures of approximately $4 \pm 2^{\circ}\text{C}$.

Sample custody (responsibility for the integrity of samples and prevention of tampering) will be the responsibility of sampling personnel until samples are shipped or delivered to the laboratory. Any containers used to ship samples via independent courier will be sealed with custody seals before shipping, and the receiving laboratory will record the condition of the seals upon arrival to ensure that the containers have not been opened during transport. Custody seals are not required for samples that are maintained under the direct custody of sampling personnel until being hand-delivered to the laboratory. Upon arrival at the laboratory, sample custody shifts to laboratory personnel, who are responsible for tracking individual samples through login, analysis, and reporting. At the time of sample login, the laboratory will assign a unique laboratory sample number, which can be cross-referenced to the field sample number and used to track analytical results.

Documents generated during sample collection will consist of:

- Sample collection field notes and forms;
- Chain-of-custody forms; and
- Shipping receipts in the event that samples are sent to a laboratory via independent courier

Sampling activities will be recorded in a project-specific field notebook, and the appropriate water sample collection form will be completed. Each sample will be identified with a unique sample number, along with the date and time of collection, on adhesive labels attached to sample bottles. All labels will be completed using waterproof ink.

Field notebooks will be used to record pertinent sampling information that is not included on Field Forms and may include the following:

- Project name
- Date and time
- Sample location
- Sample number
- Sample depth (if applicable)
- Media type
- Field meter calibration information

- Sampling personnel present
- Analyses requested
- Sample preservation
- Field parameter measurements
- Weather observations
- Other relevant project-specific site or sample information

Entries will be made in permanent ink. Corrections to field notebooks will be made by crossing out erroneous information with a single line and initialing the correction. Field books will be signed and dated at the bottom of each page by personnel making entries on that page.

Individual samples (including QC samples) will be assigned unique sample numbers according to the following sample numbering scheme:

MWx -XXX where MWx, is a 3-character code denoting the monitoring well identification (e.g., MW1) and XXX is a three-digit code that is incremented sequentially for each successive sample.

3.5 Laboratory Analytical Procedures and Reporting

Laboratory analyses will be conducted by the City of Portland Water Pollution Control Laboratory (WPCL) or an equivalent contract laboratory. Field parameters will be analyzed by field personnel using the procedures outlined above. All laboratory analyses will be fully documented and conducted in accordance with EPA-approved and/or industry standard analytical methods.

Groundwater samples will be analyzed for PFAS by liquid chromatography using EPA Method 537, diesel- and oil-range TPH by Method NWTPH-DX, VOCs by EPA Method 8260, total and dissolved metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) by EPA 200.8 methods, and PAHs by EPA Method 8270. Method reporting limits for PFAS are provided in Table 5. Available guidance on screening values for risk-based site evaluation is summarized in Table 6.

3.6 Decontamination Procedures

3.6.1 Drilling Equipment

Drilling equipment, including the auger flights and sampling tools, will be decontaminated with a high-pressure steam cleaner/pressure wash prior to each use. Decontamination water will be captured and will be stored in DOT-approved 55-gallon drums, labeled as non-hazardous waste, and stored onsite in a secure location pending receipt of the groundwater monitoring results and appropriate disposal.

3.6.2 Sampling Equipment

The following decontamination procedures will be used to decontaminate non-disposable sampling equipment:

- 1) Rinse and preclean with potable water.
- 2) Wash and scrub with non-phosphate based detergent and potable water.
- 3) Rinse with potable water.
- 4) Rinse with distilled water.
- 5) Allow to air dry between sampling events.

3.7 Investigative-Derived Waste Management

Soil cuttings generated during fieldwork will be placed into 55-gallon drums pending laboratory analysis so that appropriate disposal can be determined. Following waste characterization of the drill cuttings, the waste material will be handled as required by applicable regulations.

Decontamination water and purge water will also be drummed for pending laboratory analysis so that appropriate disposal can be determined, based on the results of the initial groundwater sampling event.

Project waste, such as Tyvek suits, gloves, paper towels, etc., will be contained in 55-gallon drums or similar containers and labeled with the date, source of waste (well number and depth), and content description. Project waste also will be staged at the designated storage area until laboratory results are available and appropriate disposal is arranged.

3.8 Data Quality

3.8.1 Field Quality Control Samples

Field QC samples will be collected and analyzed as part of the groundwater monitoring program. The following QC sample types, to be collected at a frequency of one per groundwater sampling event:

- **Equipment rinsate blank:** A rinsate blank consisting of deionized water processed through decontaminated sampling equipment, collected into sample bottles and preserved.
- **Field duplicate sample:** A field duplicate sample is a replicate sample from a single sampling location submitted to a laboratory for the same set of analyses. For the project, field duplicates will be collected by filling two sample containers consecutively from the sampling location. Duplicates will be sent to the same laboratory, but will be identified with different sample numbers. The duplicate samples will not be collected from the upgradient well.
- **Field blank:** A field blank prepared by the laboratory from an analyte-free matrix and analyzed in an analytical batch along with environmental and other QC samples. It is used to assess laboratory contamination or background interferences.

Field QC samples will be submitted blind to the laboratory (i.e., QC samples will be packaged and shipped in such a manner that the laboratory will not be aware of the nature of the samples).

3.8.2 Data Quality Evaluation

Laboratory reports containing analytical data and quality assurance/quality control (QA/QC) information will be reviewed for overall completeness of the data package. At a minimum, laboratory deliverables will include applicable notes regarding sample receipt, transmittal information, sample chain-of-custody forms, analytical results, methods and method detection limits (MDLs), method reporting limits (MRLs), and laboratory QC summaries. The reviewer will determine whether all required items are present and request copies of missing deliverables. Review of sample collection and handling procedures will include verification of the following:

- Completeness of samples submitted to laboratory for testing (i.e., where all planned samples collected)
- Completeness of field documentation, including chain-of-custody documentation.
- Field equipment calibration and maintenance and/or quality of field measurements.
- Adherence to proper sample collection procedures.

Data validation will include a detailed review of all analytical results, including:

- MDLs and MRLs
- Holding times
- Analytical methods
- Field QC sample results
- Laboratory QC sample results

Data qualifiers will be applied, if needed, to any analytical results associated with QC exceedances.

3.9 Well Abandonment

Following completion of the three planned groundwater sampling events, the City plans to abandon (i.e., decommission) the monitoring wells if significant contaminant concentrations are not detected. BES will consult with DEQ before proceeding with well abandonment. Decommissioning will be conducted by an Oregon-licensed driller and will be conducted in accordance with Oregon Water Resources Department (OWRD) regulations, and DEQ's *Monitoring Well Drilling, Construction, and Decommissioning Guidance* (1992).

4.0 Soil Investigation

4.1 Objectives

Determine if there is a presence of PFAS substances in the subsurface soil beneath the site. Soil samples will be collected from three borings within the stormwater swale where overland flow is directed via catch basins, from the cuttings of the installation of the monitoring well MW-4 in the training zone, and the collection of a composited sediment sample from the four catch basins in the training zone (Figure 2). Data collected during the investigation will be used to evaluate the presence of PFAS contamination and characterization for disposal of boring cuttings.

4.2 Drilling and Sampling Collection

Individual samples (including QC samples) will be assigned unique sample numbers according to the following sample numbering scheme: SBx -XXX where SBx, is a 3-character code denoting the monitoring well identification (e.g., MW1) and XXX is a three-digit code that is incremented sequentially for each successive sample.

4.2.1 Composite Sampling

Six soil samples will be obtained from the three locations shown on Figure 2. Soil samples will be of localized composite collected from three subsamples within an approximately 20-foot radius at 5-foot intervals to a maximum depth of 10 feet bgs. by hand auguring. Hand auguring equipment will be decontaminated by first rinsing with ultra-pure deionized water, then scrubbing with a solution of Alconox, and applying a final rinse of ultra-pure deionized water between samples.

The following procedures more specifically describe the methodology to collect subsurface composite soil samples:

- 1) Driller drives the hand auger
- 2) Driller retrieves hand auger sampler from borehole.
- 3) The sample is examined for evidence of contamination (i.e., discoloration, obvious odor, sheen).
- 4) The contents of the hand auger sampler are described on the field log.
- 5) Soil cuttings and decontamination water will be stored in U.S. Department of Transportation (DOT) approved 55-gallon drums, labeled as non-hazardous waste, and stored onsite in a secure location.

A seventh sample will be a composite of sediment from each catch basin in the training zone.

4.2.2 Discrete Sampling

During drilling for the installation of monitoring well MW-3, soil samples will be collected at 5-foot intervals with a hollow stem auger rig to a maximum depth of 10 feet bgs at the approximate location of MW-4 in Figure 2. Downhole drilling and sampling equipment will be steam-cleaned before use and before leaving the site.

The following procedures more specifically describe the methodology to collect subsurface soil samples:

- 1) Driller drives the core sampler.

- 2) Driller retrieves core sampler from borehole.
- 3) The core sampler is opened and sample recovery measured.
- 4) The core is examined for evidence of contamination (i.e., discoloration, obvious odor, sheen).
- 5) The contents of the core sampler are described on the field log.
- 6) Soil cuttings and decontamination water will be stored in U.S. Department of Transportation (DOT) approved 55-gallon drums, labeled as non-hazardous waste, and stored onsite in a secure location.

4.3 Soil Logging

Soil cores will be examined and classified in the field in general accordance with American Society for Testing and Materials (ASTM) D2488 – *Standard Practice for Description and Identification of Soils (Visual/Manual Procedure)* (ASTM, 2000). These classifications are based on a visual examination of the soil and a determination of the predominant fractions of soil (e.g., gravel, sand, silt, and clay). Approximate physical or textural soil characteristics (color, odor, coarseness, gradation, particle shape and rounding, plasticity, soil moisture conditions, consistency, etc.) will be described. The soil descriptions on the boring logs will represent a combination of field observed characteristics and drilling actions.

4.4 Laboratory Analytical Procedures and Reporting

Laboratory analyses will be conducted by the City of Portland Water Pollution Control Laboratory (WPCL) or an equivalent contract laboratory. Field parameters will be analyzed by field personnel using the procedures outlined above. All laboratory analyses will be fully documented and conducted in accordance with EPA-approved and/or industry standard analytical methods.

Soil samples will be analyzed for PFAS by mass spectrometry using EPA Method 537 Modified, diesel- and oil-range TPH by Method NWTPH-DX, VOCs by EPA Method 8260, total and dissolved metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) by EPA 6020 method, and PAHs by EPA Method 8270. Method reporting limits for PFAS are provided in Table 5. Available guidance on screening values for risk-based site evaluation is summarized in Table 7.

5.0 Reporting and Analysis

Following completion of the field investigation and upon receipt of the analytical data a groundwater reconnaissance report will be developed. Analytical results and laboratory QC/QA data will be evaluated and groundwater and soil results will be compared to appropriate and available EPA, state, and international developed screening levels as provided in Table 6 and 7. Following completion of the investigations described in this work plan the final report will be provided to the City of Portland Fire Bureau, Water Bureau, and ODEQ.

6.0 References

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Appendix A

Figures







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Portland Fire Bureau: Fire Station 2
Site Location Map
Figure 1

Legend

 Site Boundary

 Waterbodies





**Figure 2: Site Stormwater Map
Portland Fire Bureau Fire Station 2**

Legend

- | | | | | |
|------------------|-----------------------|--------------|------|------|
| Site Boundary | Catch Basin | MW-1 | MW-3 | SB-1 |
| Training Zone | Overland Flow | MW-2 | MW-4 | SB-2 |
| Stormwater Swale | Stormwater Swale Flow | | | SB-3 |
| Basin Boundary | Catch Basin Lines | Active Wells | | |
| Site Storm Line | | | | |



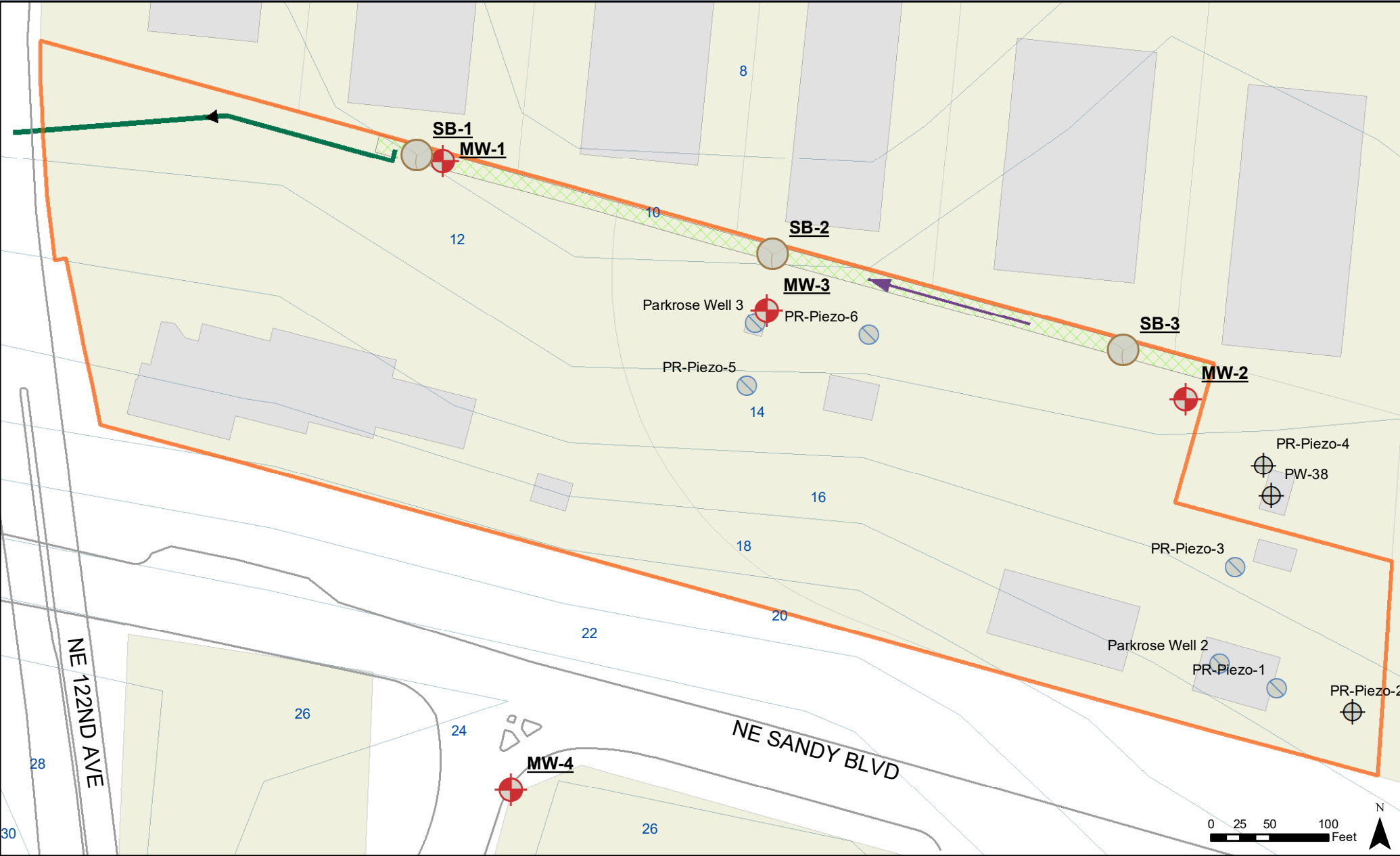



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April 9th, 2018



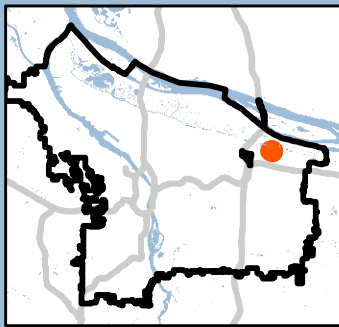
**Figure 3: Site Groundwater Map
Portland Fire Bureau Fire Station 2**

Legend

- Site Boundary
- Site Storm Line
- Stormwater Swale
- Active Wells
- Abandoned Wells
- USGS Depth to Groundwater Contour
- Stormwater Swale Flow

Proposed Borings

- MW-1
- MW-3
- SB-1
- MW-2
- MW-4
- SB-2
- SB-3



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Appendix B

Tables

Table 1. Summary of PFAS compounds to be analyzed.

PFAS Analyte	CAS #	UMCMR3	Common State analytes	Fluorotelomers
PFOA	1763-23-1	X	X	
PFOA	335-67-1	X	X	
PFHxS	355-46-4	X	X	
PFBS	375-73-5	X	X	
PFNA	375-95-1	X	X	
PFHpA	375-85-9	X	X	
PFDS	335-77-3		X	
PFTeDA	376-06-7		X	
PFTTrDA	72629-94-8		X	
PFDoA	307-55-1		X	
PFUnA	2058-94-8		X	
PFDA	335-76-2		X	
PFHxA	307-24-4		X	
PFPeA	2706-90-3		X	
PFBA	375-22-4		X	
PFOSA	754-91-6		X	
6:2 FTS	27619-97-2			X
8:2 FTS	39108-34-4			X
Gen-X (PFPrOPrA)	13252-13-6			

Table 2. Summary of hydrogeologic units in site vicinity.

Hydrogeologic Unit	Depth below ground surface (ft.)	Unit Thickness (ft.)	Unit Description
Overbank Deposits (OD)	0 -5	5	Light olive-brown silty clay & grey-brown fine-grained sandy silt
Unconsolidated Gravels/Troutdale Gravels Aquifer (UG/TGA)	5 - 225	220	Unconsolidated gravels mainly pebbly to cobbly clast supported conglomerates with silty to sandy matrix. Boulders and cemented gravels
Confining Unit 1 (CU1)	225 – 375	150	Dark grey sand, silt, and clay. Black vitric sand near bottom of unit.
Troutdale Sandstone Aquifer (TSA)	375 – 450	75	Moderate to well-sorted, angular to sub-rounded black basaltic sand. Transitions to quartzite bearing basalt conglomerate with silty to sandy matrix
Confining Unit 2 (CU2)	450 – 500	50	A leaky confining layer. Greyish olive clay with minor silt and thin lenses of fine to medium-grained basaltic sand
Sand & Gravel Aquifer (SGA)	> 500	> 200	Sand and gravel predominate the top. Grading to relatively fine-grained near the bottom.

Table 3. Summary of active and abandoned wells in the project area.

City Well Number	OWRD Well Number	Status	Screened depth bgs (ft.)	Aquifer	Static Water Level bgs (ft.)
PW-38	Mult 73084	Active	484-613	SGA	10.6
PR-Piezo-2	Not Found	Active	40-55	UG/TGA	Not Available
PR-Piezo-4	Not Found	Active	35-?	UG/TGA	Not Available
PR-Piezo-1	Mult 86249	Abandoned	21-68	UG/TGA	22
PR-Piezo-3	Mult 86252	Abandoned	21-58	UG/TGA	21
PR-Piezo-5	Mult 1163/86253	Abandoned	23-73	UG/TGA	20
PR-Piezo-6	Mult 1162/86251	Abandoned	23-43	UG/TGA	15
Parkrose Well 2	Mult 1164/1165/88501	Abandoned	33-54	UG/TGA	24
Parkrose Well 3	Mult 1161/86254	Abandoned	41-61	UG/TGA	17

Table 4. Criteria for field parameter stabilization goals

Parameter (units)	Stability Criteria*
pH (standard units)	± 0.1 pH unit
Water temperature (°C)	± 0.2 °C
Specific conductance (µmhos/cm)	± 5% (SC ≤ 100 µmhos/cm) ± 3% (SC ≥ 100 µmhos/cm)
DO milligrams per kilogram (mg/L)	± 0.3 mg/L
Turbidity (NTU) **	10% for values greater than 5 NTUs; if three values are less than 5 NTU, consider the values as stabilized
ORP/Eh (millivolts (mV) **)	±10 mV

NOTE:

* Stability criteria obtained from USGS National Field Manual for the Collection of Water Quality Data: Chapter A4, Collection of Water Samples (USGS, 2006).

** Stability criteria from the US Environmental Protection Agency (EPA) Region 1. Standard Operating Procedure for Low-Stress (low-flow) Purging and Sampling from Monitoring Wells (EPA, 2010). Available from <http://www.epa.gov/region1/lab/qa/pdfs/EQASOP-GW001.pdf>

Table 5. Standard reporting limits for PFAS provided by ALS Laboratory

Media	Reporting limit
Water	2 ng/L
Soil/Sediment	1 ug/Kg
Tissues	0.25 ug/Kg

Table 6. Standards and guidance values for PFAS in groundwater, drinking water, and surface water/effluent (wastewater). Modified from Table 4-1 belonging to ITRC PFAS Regulations, Guidance and Advisories Fact Sheet.

PFAS Analyte Concentration (µg/L) and CAS RN																				
Location	Agency / Dept	Year	Standard / Guidance	Type	Promulgated Rule (Y/N/P/R)	Footnote	PFOA	PFOS	PFNA	PFBA	PFBS	PFHxS	PFHxA	PFPeA	PFHpA	PFOSA	PFDA	PFDS, PFUnA, PFDoA, PFTrDA, PFTeDA	6:2 FTS	Gen-X
U.S. Environmental Protection Agency USEPA							335-67-1	1763-23-1	375-95-1	375-22-4	375-73-5	355-46-4	307-24-4	2706-90-3	375-85-9	754-91-6	335-76-2	335-77-3, 2058-94-8, 307-55-1, 72629-94-8, 376-06-7	27619-97-2	3252-13-6
	Office of Water	2016	HA	DW	N	a	0.07	0.07												
	Regions	2017	RSL ^b	GW	R	b	0.4	0.4			401									
	Alaska (AK)	2016	CL	GW	Y		0.40	0.40												
	Connecticut (CT)	2016	AL	GW	N	c	0.07	0.07	0.07				0.07		0.07					
	Colorado (CO)	2017	HA	DW	N		0.07	0.07												
	Delaware (DE)	2016	RL	GW	N	a	0.07	0.07												
		2016	SL	GW	N	a	0.07	0.07			38									
	Iowa (IA)	2016	Statewide Standards	Protected GW Non-protected GW	Y Y	a a	0.07 0.7	0.07 1												
Maine (ME)	CDC	2016	Health-based MEG	DW	N	a	0.07	0.07												
	DEH	2016	RAG	GW	N		0.13	0.56												
	DEH	2016		RW	N		0.05	1.2												
	DEQ	2015	HNW	SW	Y		0.42	0.011												
	DEQ	2016	GCC	GW	P		0.089	0.08												
	MDH	2017	short-term HBV	GW	N	d	0.035	0.027		7										
		2017	subchronic HBV	GW	N	d	0.035	0.027		7	9(P)									
		2017	chronic HBV	GW	N	d	0.035	0.027		7	7(P)									
	Nevada (NV)	2015	BCL	DW	N		0.667	0.667			667									
	New Hampshire (NH)	2016	AGQS	GW	Y	a	0.07	0.07												
New Jersey (NJ)	DEP	2015	ISGWQC	GW	Y				0.010											
	DEP	2017	GWQS	GW	P				0.010											
	DWQI	2017	MCL	DW	P				0.013											
	DWQI	2017	MCL	DW	Y		0.014													
	DENR	2006	IMAC	GW	Y		2													
	NCDHHS	2017		DW	N															
	DEQ	2011	IL	SW	Y		24	300	1							0.2			0.14	
	CEQ	2017	Tier 1 PCL	GW	Y		0.29	0.56	0.29	71	34	0.093	0.093	0.093	0.56	0.29	0.37	0.29		
	DEC/DOH	2016	PGWES	GW/DW	Y	a	0.02	0.02												
	International																			
DOH		2017	health-based	DW		e	0.56	0.07				0.07								
		2017	health-based	RW		e	5.6	0.7				0.7								
HC		2016	screening value	DW			0.2	0.6	0.2	30	15	0.6	0.2	0.2	0.2					
EPA		2015	health-based	DW/GW		f	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	
GMH		2006	health-based	DW			0.3	0.3												
				DW		g	0.1	0.1												
		2017	health-based	DW			0.5	0.1		7	3			3						
		2017	screening value	FW		h	0.1			7	3			3						
EPA		2011	health-based	DW				0.53												
Netherlands		2011	administrative	DW				0.0053												
		2014	health-based	DW	Y			0.09												
		2014	administrative	DW		i	0.09	0.09			0.09	0.09	0.09	0.09	0.09					
	2009	health-based	DW				10	0.3												
		2009	admin. Level 1	DW			0.3	0.3												
		2009	admin. Level 2	DW			10	1.0												
		2009	admin. Level 3	DW			90	9												

Notes:
DW standard/guidance apply to drinking water systems (public water supply).

These Tables 4.1 belongs with the ITRC PFAS Regulations, Guidance and Advisories Fact Sheet. The values included here are changing rapidly. The ITRC intends to update this table periodically as new information is gathered. The fact sheet user is encouraged to visit the ITRC PFAS web page (<http://pfas-1.itrcweb.org>) to access the current version of this file. Please see ITRC Disclaimer <http://pfas-1.itrcweb.org/about-itrc/#disclaimer>

GW standard/guidance apply to GW cleanup

The following States have adopted the EPA HA as their DW standard/guidance: AL, AZ, CO, MA, WV.

Promulgated (Yes/No/Pending/Recommended)- Values are considered promulgated Rule if they have been finalized into law or if the table of values is referenced in supporting law. Values are considered pending if either proposed into law but not yet finalized or are currently under review. Values marked as Recommended are final recommendations from an advisory board or based on available EPA calculator tool.

- a

Applies to the individual results for PFOA and PFOS, as well as the sum of PFOA + PFOS.
- b

EPA RSLs (June 2017). Calculated by the EPA RSL calculator using EPA OW RfDs, HI of 1, residential exposure assumptions.
- c

Applies to the individual results for PFOA, PFOS, PFHpA, PFNA, and PFHxS as well as the sum of concentrations of these 5 PFAS.
- d

HBVs just published May 2017 and full promulgation of HRLS anticipated in 2018.
- e

The Australian Government Department of Health values for PFOS/PFHxS are combined value when both are present.
- f

Applies to the individual results for PFOA, PFOS, PFNA, PFBA, PFBS, PFHxS, PFHxA, PFPeA, PFHpA, PFOSA, PFDA, AND 6:2 FTS as well as the sum of concentrations of these 12 PFAS.
- g

The GMH administrative guidance value of 0.1 µg/L is a composite precautionary value for both PFOA and PFOS for long term exposure in drinking water.
- h

Annual Average - Environmental Quality Standards. PFOA AA-EQS based on secondary poisoning of wildlife.
- i

Administrative value is for the sum of seven PFAS found in drinking water: PFOS, PFOA, PFHxS, PFBS, PFHpA, PFHxA, and PFPeA. PFOS is considered to be the most toxic. Water can still be used at up to 0.09 µg/L.

Regulatory Agency	Standard or Guidance	Per- and polyfluoroalkyl substances
CDC= Center for Disease Control & Prevention	AGQS = ambient groundwater quality standard	PFAS = per- and polyfluoroalkyl substances
CEQ = Commission on Environmental Quality	AL = private well action level	PFOA = perfluorooctanoic acid (C8)
DEC = Dept. of Environmental Conservation	BCL = basic comparison level	PFOS = perfluorooctane sulfonic acid (C8)
DEM = Dept. of Environmental Management	CL = groundwater cleanup level	PFNA = perfluorononanoic acid (C9)
DNREC = Dept. of Natural Resources and Environmental Control	ES = environmental standard	PFBA = perfluorobutyric acid (C4)
	GCC = Generic Cleanup Criteria (Part 201)	PFBS = perfluorobutane sulfonic acid (C4)
DEP = Dept. of Environmental Protection	HA = lifetime health advisory	PFPeA = perfluoropentanoic acid (C5)
DEQ = Dept. of Environmental Quality	HNV = human noncancer value for surface drinking water	PFHxS = perfluorohexane sulfonic acid (C6)
DES = Dept. of Environmental Services	HBV = health-based value	PFHxA = perfluorohexanoic acid (C6)
DHHR = Dept. of Health and Human Resources	HRL = health risk limit	PFHpA = perfluoroheptanoic acid (C7)
DNR = Dept. of Natural Resources	ILR = initiation level	PFOSA = perfluorooctane sulfonamide (C8)
DPH = Division or Department of Public Health	IMAC = interim maximum allowable standard	PFDA = perfluorodecanoic acid (C10)
DPHE = Department of Public Health and Environment	ISGWQC = interim specific groundwater quality criterion	PFDS = perfluorodecane sulfonate (10)
DWI = Drinking Water Inspectorate	MCL = maximum contaminant level	PFUnA = perfluoroundecanoic acid (C11)
DWQI = NJ Drinking Water Quality Institute	MEG = maximum exposure guideline	PFDoA = perfluorododecanoic acid (C12)
EPA = Environmental Protection Agency	PCL = protective concentration level	PFTrDA = perfluorotridecanoic acid (C13)
GMH = German Ministry of Health	PGWES = primary groundwater enforcement standard	PFTeDA = perfluorotetradecanoic acid (C14)
MDH = Minnesota Department of Health	PHG = public health goal	6:2 FTS = 6:2 Fluorotelomer sulfonate
SL = Screening Level	RAG = remedial action guideline	
	RL = reporting level	
	RSL = regional screening level (calculated)	

References: United States Environmental Protection Agency (USEPA)

USEPA United States Environmental Protection Agency (USEPA). 2016. *Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA)*. Office of Water (4304T). Health and Ecological Criteria Division, Washington, DC 20460. EPA Document Number: 822-R-16-005. May 2016.

USEPA United States Environmental Protection Agency (USEPA). 2016. *Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS)*. Office of Water (4304T). Health and Ecological Criteria Division, Washington, DC 20460. EPA Document Number: 822-R-16-004. May 2016.

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AK Alaska Department of Environmental Conservation (AKDEC). 2017. 18 AAC 75. Oil and Other Hazardous Substances Pollution Control. As amended through March 23, 2017. (p. 90)

CT Connecticut Department of Public Health (CTDPH). 2016. Action Levels for Private Wells. February 2013. Perfluorinated substances added to the list in November 2016.

CO Colorado Department of Public Health and the Environment (CDPHE). PFCs Health Advisory, 2017.

DE - RL Delaware Department of Natural Resources and Environmental Control (DNREC). 2016. *Guidance for Notification Requirements*. January 2013. *Reporting Level Table*. Updated July 2016. Division of Waste and Hazardous Substances. Site Investigation & Restoration Section. July 2016.

DE - SL Delaware Department of Natural Resources and Environmental Control (DNREC). 2016. Screening Level Table. Division of Waste and Hazardous Substances. Site Investigation & Restoration Section. January 1, 2013. Last Updated July 2016.

IA Iowa Department of Natural Resources (IDNR). 2016. Statewide standards for contaminants in soil and groundwater.

ME -DW Maine Center for Disease Control and Prevention (MeCDC). 2017. Summary of the 2016 Updates to the Maximum Exposure Guidelines. Published January 10, 2017.

ME -GW Maine Department of Environmental Health (DEH). 2016. Maine Remedial Action Guidelines (RAGs) for Sites Contaminated with Hazardous Substances. February 5. (p. 46)

ME-RW Maine Department of Environmental Health (DEH). 2014. Human health risk-based screening levels for perfluoroalkyl compounds. Maine Center for Disease Control and Prevention. Department of Health and Human Services. June 6, 2014.

MI-SW Michigan Department of Environmental Quality (DEQ). 2016. Rule 57 Water Quality Values. Surface Water Assessment Section. October 21, 2016.

MI-GW Michigan Department of Environmental Quality (DEQ). 2016. Remediation and Redevelopment Division. Environmental Contamination Response Activity Rules. September 2016.

MN Minnesota Department of Health (DOH). 2017. Human Health-Based Water Guidance Table.

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NH New Hampshire Code of Administrative Rules. Chapter Env-Or 600- Contaminated Site Management (11/10/17)

NJ -GW State of New Jersey Department of Environmental Protection. 2016. Ground Water Quality Standards N.J.A.C. 7-9C: Interim Ground Water Quality Criteria Table. Last Updated August 12, 2016.

NJ -DW State of New Jersey Department of Environmental Protection. Memorandum to Barker Hamill, Assistant Director for Water Supply Operations, from Gloria Post, Ph.D. DABT, Research Scientist, Risk Analysis Section, DSRT. Subject: Guidance for PFOA in Drinking Water at Pennsgrove Water Supply Company.

This Tables 4.1 belongs with the ITRC PFAS Regulations, Guidance and Advisories Fact Sheet. The values included here are changing rapidly. The ITRC intends to update this table periodically as new information is gathered. The fact sheet user is encouraged to visit the ITRC PFAS web page (<http://pfas-1.itrcweb.org>) to access the current version of this file. Please see ITRC Disclaimer <http://pfas-1.itrcweb.org/about-itrc/#disclaimer>

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North Carolina Department of Environmental Quality (NCDEC) 2013. Appendix #1: Interim maximum allowable concentrations (IMACs). May 22, 2013.

NC

OR Oregon Department of Environmental Quality (DEQ). Division 045. Regulations Pertaining to NPDES and WPCF Permits. Initiation Level Rule 340-045-0100.
TX Texas Commission on Environmental Quality (TCEQ). 2017. Texas Risk Reduction Program (TRRP). Protective Concentration Levels (PCLs). March.
VT Vermont Agency of Natural Resources Department of Environmental Conservation (DEC). 2016. Chapter 12 of the Environmental Protection Rule and Strategy. Adopted December 16, 2016.

References: U.S. States that have adopted USEPA HA

AL Alabama Department of Environmental Management (ADEM). ADEM Announces EPA National Health Advisory. May 19, 2016.
AZ Liberty Utilities. 2017. Notice to Our Communities: Avondale, Goodyear, Litchfield Park, and Maricopa County. Notice in response to EPA Drinking Water Health Advisories for PFOS and PFOA.
CO Colorado Department of Public Health & Environment. 2017. PFCs - EPA health advisory.
MA Massachusetts Department of Environmental Protection (DEP). 2017. Draft Fact Sheet. Guidance on Sampling and Analysis for PFAS at Disposal Sites Regulated under the Massachusetts Contingency Plan. January 2017.
WV West Virginia Department of Health and Human Resources. 2016. Perfluorinated compounds drinking water health advisory. Bureau of Public Health.

References: International

Australia Australian Government Department of Health. Health Based Guidance Values for PFAS. For Use in Site Investigations in Australia.
Canada Health Canada. 2016. Health Canada's Drinking Water Screening Values for Perfluoroalkylated Substances (PFAS). February 2016.
Denmark Danish Ministry of the Environment . 2015. Perfluoroalkylated substances: PFOA, PFOS and PFOSA. Evaluation of health hazards and proposal of a health based quality criterion for drinking water, soil and ground water. Environmental project No. 1665, 2015.
Germany German Ministry of Health at the Federal Environment Agency. Assessment of PFOA in the drinking water of the German Hochsauerlandkreis. Statement by the Drinking Water commission (Trinkwasserkommission) of the German Ministry of Health at the Federal Environment Agency. June 21, 2006/ revised July 13, 2006.
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Sweden Concawe. 2016. Environmental fate and effects of poly- and perfluoroalkyl substances (PFAS). Report no. 8/16.
UK United Kingdom Drinking Water Inspectorate (DWI). Guardians of drinking water quality. 2009. Guidance on the Water Supply (Water Quality) Regulations 2000 specific to PFOS (perfluorooctane sulphonate) and PFOA (perfluorooctanoic acid) concentrations in drinking water. October 2009.

Table 7. Residential soil standards and guidance values for PFAS. Modified from Table 4-1 belonging to ITRC PFAS Regulations, Guidance and Advisories Fact Sheet.

Soil Screening Levels for Groundwater Protection (mg/kg)										Human Health Soil Screening Level (mg/kg)									
U.S.										U.S. States									
PFAS	Agency Department/ Year Standard	USEPA	Alaska	U.S. States		North Carolina	Texas	Texas		USEPA	Alaska	Delaware	Michigan	Minnesota	Nevada	New Hampshire	North Carolina	Texas	Texas
		Regions	DEC	Alaska	Michigan	DEQ	CEQ	CEQ		Regions	DEC	DNREC	DEQ	PCA	NDEP	DES - EHP	DEQ	CEQ	CEQ
		2017	2017	2017	2016	2016	2017	2017		2017	2017	2016	2016	2016	2017	2017	2016	2017	2016
		RSL	CL	GCC	Surface Water	PSRG	PCL	PCL	30 acre source	RSL	CL ^b		GCC	SRV	BCL	DCRB	PSRG	PCL	ISL ^c
				Ground- water			0.5 acre source	0.5 acre source										0.5 acre source	
PFNA	375-95-1	--	--	--	--	--	0.003	0.0015		--	--	--	--	--	--	--	--	0.8	--
PFOA	335-67-1	0.000172	0.0017	0.075	10	0.0081	0.003	0.0015		1.26	1.3	16	6	0.33	1.56	0.5	--	0.6	16
PFOS	1763-23-1	0.000378	0.003	0.0024	0.00024	--	0.05	0.025		1.26	1.3	6	3.2	1.7	1.56	0.5	--	1.5	6
PFBA	375-22-4	--	--	--	--	--	0.2	0.098		--	--	--	--	63		--	--	180	--
PFBS	375-73-5	0.13	--	--	--	--	0.11	0.053		1260	--	160	--	30	125	--	320	86	--
PFPeA	2706-90-3	--	--	--	--	--	0.00032	0.00016		--	--	--	--	--	--	--	--	0.3	--
PFHxS	355-46-4	--	--	--	--	--	0.002	0.001		--	--	--	--	--	--	--	--	0.3	6
PFHxA	307-24-4	--	--	--	--	--	0.00048	0.00024		--	--	--	--	--	--	--	--	0.3	--
PFHpA	375-85-9	--	--	--	--	--	0.0046	0.0023		--	--	--	--	--	--	--	--	1.5	--
PFOSA	754-91-6	--	--	--	--	--	0.92	0.46		--	--	--	--	--	--	--	--	0.058	--
PFDA	335-76-2	--	--	--	--	--	0.022	0.011		--	--	--	--	--	--	--	--	0.99	--
PFDS	335-77-3	--	--	--	--	--	0.04	0.02		--	--	--	--	--	--	--	--	0.8	--
PFUnA	2058-94-8	--	--	--	--	--	0.018	0.0092		--	--	--	--	--	--	--	--	0.8	--
PFDoA	307-55-1	--	--	--	--	--	0.034	0.017		--	--	--	--	--	--	--	--	0.8	--
PFTrDA	72629-94-8	--	--	--	--	--	0.061	0.03		--	--	--	--	--	--	--	--	0.6	--
PFTeDA	376-06-7	--	--	--	--	--	0.11	0.056		--	--	--	--	--	--	--	--	0.5	--
6:2 FTS	27619-97-2	--	--	--	--	--				--	--	--	--	--	--	--	--	--	60

Notes:

- a. EPA RSLs (June 2017). Calculated by the EPA RSL calculator using EPA OW RfDs, HI of 1, residential exposure assumptions.
- b. Alaska proposed cleanup levels for Human Health - most stringent value is from the "Over 40 Inch Zone".
- c. Interim screening level for contaminated sites
- d. Applies to the individual results for PFOA, PFOS, PFNA, PFBA, PFBS, PFHxS, PFHpA, PFPeA, PFHxA, PFOS, PFDA, AND 6:2 FTS as well as the sum of concentrations of these 12 PFAS.

Regulatory Agency

CEQ = Commission on Environmental Quality
DEC = Department of Environmental Conservation
DENR = Department of Environment and Natural Resources

DES-EHP = Department of Environmental Services-Environmental Health Program
DEQ = Department of Environmental Quality
DER = Department of Environment Regulation
DOD = Department of Defense
HC = Health Canada
PCA = Pollution Control Agency
USEPA = United States Environmental Protection Agency

Per- and polyfluoroalkyl substances

PFAS = per- and polyfluoroalkyl substances
PFOA = perfluorooctanoic acid (C8)
PFOS = perfluorooctane sulfonic acid (C8)
PFNA = perfluorononanoic acid (C9)
PFBA = perfluorobutyric acid (C4)
PFBS = perfluorobutane sulfonic acid (C4)
PFPeA = perfluoropentanoic acid (C5)
PFHxS = perfluorohexane sulfonic acid (C6)
PFHxA = perfluorohexanoic acid (C6)
PFHpA = perfluoroheptanoic acid (C7)
PFOSA = perfluorooctane sulfonamide (C8)
PFDA = perfluorodecanoic acid (C10)
PFDS = perfluorodecane sulfonate (10)
PFUnA = perfluoroundecanoic acid (C11)
PFDoA = perfluorododecanoic acid (C12)
PFTrDA = perfluorotridecanoic acid (C13)
PFTeDA = perfluorotetradecanoic acid (C14)
6:2 FTS = 6:2 Fluorotelomer sulfonate

Standard

BCL= Basic Comparison Levels
CL = Cleanup Level
DCRB = Direct Contact Risk-Based concentration
GCC = Generic Cleanup Criteria
ISL = Interim Screening Level
PCL = Protective Concentration Level
PSRG = Preliminary Soil Remediation Goal
RSL = Regional Screening Level

SRV = Soil Reference Value	
SSV = Soil Screening Value	
<u>References: U.S.</u>	
<u>States</u>	
USEPA	United States Environmental Protection Agency (USEPA). 2017. Regional Screening Levels (RSLs) calculated using the RSL Calculator (June 2017).
AK	Alaska Department of Environmental Conservation (ADEC). 2017. 18 AAC 75, Oil and Other Hazardous Substances Pollution Control. As amended through March 23, 2017. (p. 79)
DE	Delaware Department of Natural Resources and Environmental Control (DNREC). 2016. Screening Level Table. Division of Waste and Hazardous Substances. Site Investigation & Restoration Section. January 1, 2013. Last Updated July 2016.
CO	Colorado Department of Public Health and the Environment (CDPHE). PFCs Health Advisory, 2017.
	Michigan Department of Environmental Quality (DEQ). 2016. Remediation and Redevelopment Division. Environmental Contamination Response Activity. Table 2. Chemical-specific Data, Part 201 Generic Cleanup Criteria and Screening Levels/Part 213 Risk-based Screening Levels. Page 307. September 2016.
MI	
MN	Minnesota Pollution Control Agency (PCA) Risk-Based Site Evaluation Guidance, Draft Soil Reference Value (SRV) Technical Support Document and SRV Spreadsheets as of September 2016.
NC	North Carolina Department of Environmental Quality (DEQ). 2016. Inactive Hazardous Sites Guidance. Preliminary Soil Remediation Goals (PSRG) Table. October 2016.
NH	New Hampshire Department of Environmental Services-Environmental Health Program. Direct Contact Risk-Based Soil Concentration. Perfluorooctanoic Acid. CAS #335-67-1. June 17, 2016
	New Hampshire Department of Environmental Services-Environmental Health Program. Direct Contact Risk-Based Soil Concentration. Perfluorooctane Sulfonate. CAS #1763-23-1 . June 28, 2016
TX	Texas Commission on Environmental Quality (TCEQ). 2017. Texas Risk Reduction Program (TRRP) Tier 1 Protective Concentration Levels (PCLs). March 31.
<u>References:</u>	
<u>International</u>	
Australia	Australia Department of Defense (DOD). 2016. Defence Contamination Directive (DCD) #* (Amendment 1) – Interim Screening Criteria. Defence Project Guidance for Per- and Poly-Fluoroalkyl Substances (PFAS). Version 3.0. September.
W. Australia	Government of Western Australia Department of Environment Regulation (DER). 2017. <i>Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)</i> . Contaminated Sites Guidelines. January.
Canada	Updates to Health Canada Soil Screening Values for Perfluoroalkylated Substances (PFAS). Health Canada. January 2017.
Denmark	Danish Ministry of the Environment. 2015. Perfluoroalkylated substances: PFOA, PFOS and PFOSA. Evaluation of health hazards and proposal of a health based quality criterion for drinking water, soil and ground water. Environmental project No. 1665, 2015.